DESCRIPTION

LINE-ILLUMINATING DEVICE AND IMAGE-SCANNING DEVICE INCORPORATING LINE-ILLUMINATING DEVICE

Technical Field

[001] The present invention relates to a line-illuminating device and a contact-type image-scanning device (image sensor) in which the line-illuminating device is incorporated.

Background Art

[002] A contact-type image sensor is used as a device for scanning a document in a facsimile machine, a copying machine, an image scanner or the like. The contact-type image sensor is provided with a line-illuminating device for linearly illuminating a document surface along a main scanning field.

[003] In the line-illuminating device, a bar-shaped light guide is accommodated in a casing, light from a light source (LED) is introduced into the bar-shaped light guide, and the light is allowed to reflect within the bar-shaped light guide and be emitted from a light-emitting surface along the longitudinal direction of the bar-shaped light guide toward the document surface, in which the light-emitting surface is exposed from the casing (Patent Documents 1 and 2). There have been known a type in which a light source is provided on one end of the casing, and a type in which light sources are provided on both ends of the casing.

[Patent Document 1] Japanese Patent Application Publication No. 8-163320

[Patent Document 2] Japanese Patent Application Publication No. 10-126581

[004] Among the conventional line-illuminating devices, as for the type in which a light source is provided on one end, the light amount is insufficient, and the illumination intensity is non-uniform along the main scanning direction. Thus, a light-scattering pattern is provided. However, it is still difficult to completely solve the problem of

non-uniformity.

[005] In contrast, as for the type in which light sources are provided on both ends, a problem is caused by thermal expansion. Specifically, while the temperature of the contact-type image sensor rises to quite a high temperature at the time of driving, it is cooled to around a room temperature at the time of stopping. The material of the casing is typically polycarbonate, and the material of the light guide is acrylic. Therefore, relative expansion and shrinkage repetitively occur between the casing and the light guide due to the difference in the thermal expansion coefficient. This results in the light guide shrinkage compared to the casing, which causes a gap between the end surface of the light guide and the light source, and part of light generated by the light source unpreferably leaks.

Disclosure of the Invention

[006] In order to solve the above-mentioned problems, according to a first aspect of the present invention, light sources are provided on both ends of a casing of a light-illuminating device, and the casing is divided, for example, into two portions in the longitudinal direction.

[007] By providing a gap between the two divided portions of the casing, when the light guide expands or shrinks, the casing correspondingly expands or shrinks, whereby the light source can be kept abut against the end surface of the light guide.

[008] The divided portions may be apart from each other. However, if they are slidably engaged with each other, it is possible to prevent light from leaking from the light guide.

[009] According to a second aspect of the present invention, light sources are provided on both ends of a casing of a light-illuminating device, and the light source is pressed against the end surface of the light guide with an elastic member which is formed integrally with the casing.

[010] In this instance, it is preferable that the end of the light guide be projected from the end of the casing in an estimated amount of shrinkage.

[011] According to a third aspect of the present invention, a light source is attached to a casing on one end of a casing of a light-illuminating device in the same manner as the conventional art, and another light source is attached directly to the end surface of the light guide. Incidentally, the light sources may be attached directly to the end surface of the light guide on both sides.

[012] As a method for attaching, there is a method in which a raised portion is provided on the end surface of the light guide and the light source is engaged with the raised portion.

Brief Description of the Drawings

[013] FIG. 1 is a sectional view of an image scanning device in which a line-illuminating device according to the present invention is incorporated;

[014] FIG. 2 is a perspective view of the line-illuminating device according to the present invention;

[015] FIG. 3 is an exploded perspective view of the line-illuminating device;

[016] FIG. 4 is a sectional view of the intermediate portion of a casing;

[017] FIG. 5 is a similar view to FIG. 4 showing another embodiment;

[018] FIG. 6 is a view showing a main part of another embodiment in which an elastic member is provided in the casing; and

[019] FIG. 7 is a view showing a main part of another embodiment in which a light-emitting element is attached directly to the light guide.

Best Mode for Carrying Out the Invention

[020] Preferred embodiments of the present invention will now be described with reference to the accompanying drawings. FIG. 1 is a sectional view of an image scanning device in which a line-illuminating device according to the present invention is incorporated, FIG. 2 is a perspective view of the line-illuminating device according to the present invention, FIG. 3 is an exploded perspective view of the line-illuminating device, and FIG. 4 is a sectional view of the intermediate portion of a casing.

[021] As shown in FIG. 1, an image scanning device is comprised of a frame 1 having recessed portions 1a and 1b, a line-illuminating device 10 provided in the recessed portion 1a, a sensor substrate 4 with a photoelectric transducer element (line image sensor) 3 attached to the recessed portion 1b, and a rod lens array 5 for unit magnification imaging which is held within the frame 1. A glass plate 2 is provided above the frame 1. Light emitted from a line-emitting surface 11a of the line-illuminating device 10 is directed to a document G through the glass plate 2, the light reflected on the document G goes to the rod lens array 5 and is detected by the photoelectric transducer element (line image sensor) 3 so as to scan the document G. The frame 1 is moved with respect to the glass plate 2 in a sub-scanning direction, so that a desired area of the document G can be scanned.

[022] As shown in FIG. 2, the line-illuminating device 10 is comprised of a white casing 12 made of polycarbonate or the like, a light guide 11 made of an acrylic resin or the like and accommodated in the casing 12 such that the light-emitting surface 11a is exposed, and light-emitting elements (for example, light-emitting diodes) 13 as a light source provided on both ends of the casing 12 so as to abut against the end surfaces of the light guide 11 without a gap.

[023] The bottom surface of the light guide 11 is provided with a light scattering pattern 11b for allowing the light emitted from the light source to scatter. The light scattered by the light scattering pattern 11b is emitted from the light-emitting surface 11a.

[024] As shown in FIG. 3, three pins P1, P2, and P3 are formed on the end of the casing 12. The pin P1 and the pin P2 are located in an opposite position with respect to each other, and the pin P1 and the pin P2 have the same diameter. The pin P3 is located adjacent to the pin P1, and the diameter of the pin P3 is smaller than that of the pin P1 and the pin P2.

[025] On the other hand, the light-emitting element 13 is provided with three holes H1, H2, and H3 corresponding to the three pins, respectively. The hole H1 and the

hole H2 correspond to the pin P1 and the pin P2, respectively, and the hole H3 corresponds to the pin P3, which means that the diameter of the hole H3 is smaller than that of the other holes and the pin P1 and the pin P2 cannot enter the hole H3. Consequently, coupling of the pin to the wrong hole can be prevented.

[026] As shown in FIG. 4, the casing 12 is divided into two portions in the longitudinal direction, and a gap 14 is formed between the two divided portions 12a. With this gap, even if the light guide 11 shrinks due to repetition of heating and cooling, the divided portions 12a shrink together with the light guide 11, and the abutting state between the end surface of the light guide 11 and the light-emitting element 13 can be maintained.

[027] FIG. 5 is a similar view to FIG. 4 showing another embodiment. In this embodiment, the left and the right divided portions 12a are engaged with respect to each other so as to prevent the light guide 11 from being exposed.

[028] In another embodiment shown in FIG. 6 using a unique attachment structure of the light-emitting element 13, the end surface of the light guide 11 and the light-emitting element 13 can be prevented from being separated due to the difference in the thermal expansion coefficient. Specifically, an elastic member 15 is formed integrally with the end of the casing 12, so that the light-emitting element 13 can be pressed against the end surface of the light guide 11.

[029] In this embodiment, the light guide 11 is projected from the end of the casing 12 in an estimated amount (t) of shrinkage of the light guide 11.

[030] In another embodiment shown in FIG. 7, a modified attachment structure of the light-emitting element 13 is used. In this embodiment, no pin is provided in the casing 12. Instead, the pins P1, P2 and P3 are provided in the light guide 11, and the light-emitting element 13 is attached directly to the end surface of the light guide 11. In these embodiments shown in FIGS. 6 and 7, the above-mentioned attachment structure may be used only on one end of the light-illuminating device, and a conventional attachment structure may be used on the other end.

Industrial Applicability

[031] As mentioned above, according to the present invention, in the line-illuminating device comprising the casing and the light guide which are made of a different material, since the casing is divided into two portions in the longitudinal direction, the light-emitting element is pressed against the end surface of the light guide with the elastic member all the time, or the light-emitting element is attached directly to the end surface of the light guide, even if heating and cooling are repeated a plurality of times and the light guide shrinks compared to the casing, the abutting state between the light-emitting element and the end surface of the light guide can be maintained and light can be introduced into the light guide effectively.